Natural language processing based Services Composition for Environmental management

Paolo Falcarin
Armando Ordonez
Juan Carlos Corrales

SOSE– Genoa– 18/7/2012
Outline

- Convergent composition in the Environmental management domain
  - Proposed architecture
  - Request Analysis
  - Context Analyzer
  - Service Composer
Convergent composition

Convergence is:
Mobile & PSTN (Moyer, 2001)
NGN (Vrdoljak 2000)

- Convergent Composition (Lopez, 2007)
- Telco 2.0 (Yoon 2007)
- Unified Composition (Bond 2010)
Environmental management domain

- Environmental manager is the decision-maker for saving crops from environment alarms (high/low temperature, floods)
- Information comes from sensor networks
- Available Telco and Web services process basic data and can send information to all the farmers and sensors
- Service Reuse is a very important issue for developing countries where budgets for technologies are limited
Case Study: Environmental Management

- Sensor Network
  - River Flow
  - PH

- Environmental Manager
- Web Services
  - Google Maps
  - NASA Maps
  - ESRIMaps

- Environmental Services
  - Calculus
  - Projections

- Sensor Network
  - Humidity
  - Temperature

- Telco Services
  - SMS
  - PSTN
  - Cell Calls

University of East London
Domain features

- Convergent services
  - Composition of Web Services with Telecom features (Phone–Call, send SMS)
- Limited number of services
  - Environment Management is a very specific domain
- Environment Management
  - Standard Procedures for monitoring and management of emergencies
  - Services can be described with semantic annotations by domain-experts
Case Study: Environmental Management

I need to calculate hydrological balance of zone 1 and receive the resulting map on my mobile phone.
Case Study: Environmental Management

If the river flow of zone 2 is greater than 15% of average, alarm each farmer within 2 miles from the river.
Outline

- Convergent composition in the Environmental management domain
  - Proposed architecture
  - Request Analysis
  - Context Analyzer
  - Service Composer
Proposed Architecture

REQUEST ANALYSIS
- Context Analyzer
- NLP Analyzer
- Voice to text

Context information
- Planning problem
- Control flow

Enriched services descriptions

SERVICE COMPOSER
- AI Planner + Reconfiguration
- Service Discovery

Services Implementation descriptions

ENTERPRISE SERVICE BUS
Outline

- Convergent composition in the Environmental management domain
- Proposed architecture
  - Request Analysis
  - Context Analyzer
  - Service Composer
Request analysis

- It is made of two sub components:
  - *Context Analyzer*
  - *NLP Analyzer*

\[ Q = \langle R; P \rangle \]

- Q: is a request made by an environmental manager from a mobile phone
  - \( P: \textit{User Context}: \text{Cell phone reference and network capabilities.} \)
  - \( R: \textit{Request}: \text{“I need calculate hydrological balance of zone one and receive the resulting map to my mobile”}. \)
Natural Language Analyzer

1. Tokenizing Text
   - Use dictionary to separate words in a sentence
   - Stemming
     - reduce words to their root (e.g. checks => check)
   - Spell-checking

2. Detect which words are:
   - verbs (possible actions -> services)
   - nouns (possible parameters -> input/output)
   - Prepositions - AND, OR (control flow information)

3. Produce a PDDL description
Request analysis: example

- Request R is decomposed in Sentences \{s_1, s_2, \ldots, s_n\} and Flow Information F
  - s1: “calculate hydrological balance of zone one”
  - s2: “receive the resulting map to my mobile”
  - F: AND (sequence of actions)
- Analysis of \( s_1 \): “calculate hydrological balance of zone one”
  - Input = Zone ONE (A system variable, geo-coded location or a set of coordinates)
  - Output = Hydrological balance map
  - Action = Calculate hydrological balance service
Outline

- Convergent composition in the Environmental management domain
- Proposed architecture
- Request Analysis
  - Context Analyzer
  - Service Composer
Context analyzer

- Extracts user context information
  - mapped to services criteria problem in PDDL
- Context analysis is made of two tasks:
  - User profile analysed looking for preferences
  - Device references are checked in capabilities repositories
    - Wireless Universal Resource File (WURFL)
    - Composite Capability/Preference Profiles (CC/PP)
# User context criteria

<table>
<thead>
<tr>
<th>User context</th>
<th>User Criteria</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network</td>
<td>GPRS/ WLAN/ GSM</td>
<td></td>
</tr>
<tr>
<td>Device</td>
<td>Cell phone, Laptop</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Outdoor, indoor</td>
<td></td>
</tr>
<tr>
<td>User preferences</td>
<td>Data subscription</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>Only Free services</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>Voice subscription</td>
<td>Yes/No</td>
</tr>
<tr>
<td></td>
<td>Delivery quality</td>
<td>low, medium, high</td>
</tr>
</tbody>
</table>
Outline

- Convergent composition in the Environmental management domain
- Proposed architecture
- Request Analysis
- Context Analyzer
- Service Composer
Service Composer

Context Info → Planner (PDDL) → Service Composition

Sentences (Input-Output-Action) → Control Flow

Service Descriptions → JSLEE ESB
Service Descriptions generation

- Service Descriptions in PDDL are annotated with tags by domain experts.
- Tags should correspond to tokens in sentences
- Tags used to map user goals to available services
Deployment on JSLEE ESB

- Event-based Java Application Server
- Service: Composition of Service Building Blocks
- Resource Adapters bridge to different networks